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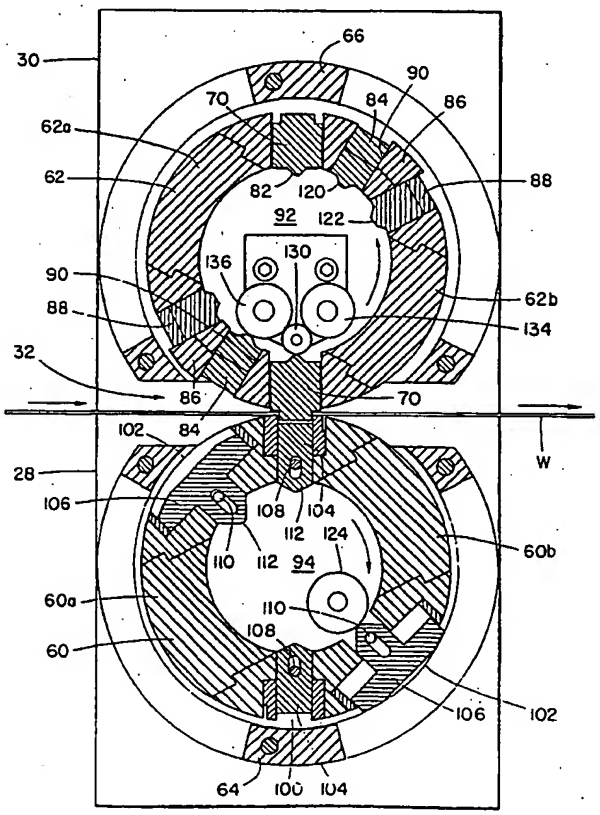

(57) Abstract: A rotary punching apparatus (10) for punching openings (14) in a moving web workpiece (w) the openings having a predetermined length along the longitudinal axis of the web and having a pair of die assemblies (60, 62) located on opposite sides of the path of the web (w) and a drive (54) for rotating the assemblies, a leading die (84) mounted on one assembly, and being moveable for generally radially so as to punch a die opening through the web, a mating die recess punched in the other of the assemblies; and, a trailing die (88) adjacent to the leading die (84), being located to punch the web at a point adjacent the punched die opening so as to punch a second die opening in the web, the first die opening and the trailing die opening together defining a continuous opening (14) having a predetermined length along the web. Also disclosed is a method of rotary punching by use of such apparatus.

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ROTARY PUNCHING APPARATUS

FIELD OF THE INVENTION

The invention relates to a rotary punch apparatus for punching or piercing openings in moving web sheet material, and in particular for punched openings having significant length along the longitudinal axis of the moving web .

BACKGROUND OF THE INVENTION

Making openings by punching into a moving web has been carried on for many years. Where the openings were relatively small, ie short along the longitudinal axis of the moving web , then simple rotary dies could be used satisfactorily, in many cases. However, where the openings were elongated or had significant length along the longitudinal axis of the moving web, a simple rotary die, or dies carried on a rotating drum or roll, could not be used. In this case the industry has used so-called flying dies. These were dies which were mounted on carriage moveable along linear rails. The carriages were movable in a straight line intermittently to and fro along the longitudinal axis of the moving web. The carriages would accelerate from a stationary position and reach the linear speed of the moving web. At this point the carriages would move towards one another, closing the dies on the web, and thereby punching or piercing the opening while the dies were moving longitudinally, with the web. The dies would then open, and the carriage would move back along the rails to the start position. This system required the use of relatively expensive equipment, and the control of the carriage required sophisticated computer controls. These were needed to ensure that the carriage reached a speed matching the speed of the moving web, and that the dies closed at exactly the right moment to make the opening at the precise point required. Another more serious problem was the fact that stopping the carriage and reversing it, and then restarting it once more to accelerate for the next opening, required a measurable length of time. During this time no openings could be made in the web. If the design of the web product called for openings at closely spaced intervals, then there were one of two solutions:

1. Either the web had to be slowed down so that its speed was slow enough to give the die carriage time to return to its start position, and then start its next acceleration, or
2. The line would be built with two or more such flying die carriages, mounted in tandem and operating in sequence.

Either solution was in practice expensive and unacceptable. Slowing down the web reduced the production volume per shift, and thereby increased product cost. Installing two or more flying die carriages was both expensive, and required even more sophisticated controls to ensure that the openings were in the right locations in the moving web.

The sheet metal industry, in particular, requires the production of web products having openings at relatively close spacings, and these openings have significant length along the longitudinal axis of the web. For example one sheet metal web product which is widely used is a so-called dry wall stud. This is a generally C-shaped channel, made of web sheet metal, which is used in erecting walls and partitions, usually interior partitions , in all kinds of office, commercial and industrial buildings. The market for this product, in particular, is highly competitive and manufacturers are constantly looking for ways to reduce their costs, and maintain market share. Such dry wall studs are made with relatively large or elongate openings at closely spaced intervals. These openings are required in construction to permit plumbing and electrical and other services to pass along the interior of the walls.

This is merely one example of a typical product which may be made from a continuously moving web. Numerous other products may be made from such a moving web. The web may be metallic or non metallic. The end product may be a web product with openings, or, in other cases the end product may be the portions of the web which are punched out from the web.

Clearly there is a need for a punching or piercing apparatus which can punch or pierce out relatively large or elongate openings from a moving web without the problems described above in connection with flying dies and moving carriages. Preferably such an apparatus will be based on a rotary drum or roll, on which dies are mounted so that openings may be punched out or pierced, referred to herein as "punched", at desired intervals and as close as may be required , without delaying production or causing extra expense. Relatively simple controls will be provided to ensure that the rotary dies, or rolls carrying the dies, are operated in timed relation to the movement of the web along the production line, and that when no openings are required the rolls are inactive and the web can pass between the rolls without openings being punched. Openings having "significant" length along the web axis are referred to herein as "elongate openings" whether round, rectangular or any other shape. "Elongate openings" also includes objects or pieces which are stamped out of a web.

BRIEF SUMMARY OF THE INVENTION

With a view to achieving the foregoing objectives the invention comprises a rotary punching apparatus for punching openings in a moving web workpiece the openings having a significant length along the longitudinal axis of the web and having a pair of rolls located on opposite sides of the path of the web workpiece, and power means for rotating the rolls and having at least a leading die mounted on one said roll of said pair, and movement means for moving said die generally outwardly relative to said roll so as to punch a leading die opening through said web, said leading die opening defining a leading edge and a trailing web portion, and there being a mating leading die recess in the other of said rolls, and further having a second die adjacent to said first die, said second die being located to engage and punch the web at a point adjacent the web portion trailing portion of the leading die opening whereby to punch a continuation of said leading die opening in said web, said first die opening thereby defining a continuous opening having significant length along said longitudinal axis of said web and defining a trailing edge remote from said leading edge.

The invention preferably provides that a median die is fastened relative to said roll between the leading and trailing dies so that it does not move outwardly, and in this way acts to continue and to extend the leading die opening.

In a particularly advantageous embodiment, the invention provides a trailing die being moveable whereby to punch said web and define a trailing edge of said opening.

The invention may also provide at least a hole punch die moveable outwardly relative to said roll operable to punch a further opening in the web spaced axially along the longitudinal axis of the web from the said elongate opening punched by the leading and trailing dies.

The invention preferably provides power operated means for rotating the rolls, the power operated means being operable intermittently so as to punch the openings at desired longitudinal spacings along the axis of the web, the rolls being held inactive where openings are not required so as to permit the web to pass between them without openings being punched. The power operated means may be an intermittently operable motor, or may include a clutch so that the motor can operate continuously, and the clutch being operable to deliver rotary power to the rolls when required.

The invention may be built as rolls which extend across the width of the web and being rotatably mounted on bearings on either side edge of the web.

In a preferred case the rolls are mounted on a single stand in a cantilever fashion located along one side edge only of the web path, the rolls being long enough to extend partly across the web to locate the dies along the desired axis of the web.

The invention provides die operating means such as of cam means. The leading dies are mounted on supports extending into the roll and terminating in followers located to be engaged by the cam means. The trailing and hole punch dies are similarly mounted and engaged by cam means.

The invention provides die recesses in the other of the rolls registering with their respective dies and receiving portions of the web which are punched out. Knock out means are preferably provided to eject the punched out web portions from the recesses.

The various features of novelty which characterize the invention are pointed out with more particularity in the claims annexed to and a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

IN THE DRAWINGS

Figure 1 is a general perspective of a rotary apparatus for punching openings in a moving web workpiece illustrating the invention, and showing the web in phantom with openings punched downstream of the apparatus;

Figure 2 is a section along the line 2-2 of Fig. 1;

Figure 3 is a top plan view of a portion of the web workpiece shown with short holes and elongate holes punched therein;

Figure 4 is a perspective illustration of a finished article, in this case a piece of structural steel, such as is used for supporting drywall and the like;

Figure 5 is a perspective illustration of a punch die;

Figure 6 is a perspective illustration of another punch die;

Figure 7 is a perspective illustration of a fixed intermediate punched die;

Figure 8 is a perspective illustration of a trailing punched die;

Figure 9 is a schematic view corresponding to Fig. 4 and 5 showing the punching of a separate short opening by a hole punch die at a fourth rotary position of the apparatus;

Figure 10, 11 and 12 show further positions for punching the short openings;

Figure 13 is schematic view corresponding to Fig 3 showing the punching of an elongated opening by a lead die, at a leading rotary position of the apparatus; and,

Figures 14, 15, 16, 17 and 18 show further positions for punching the elongate openings.

DESCRIPTION OF A SPECIFIC EMBODIMENT

Referring first of all to Figure 1 it will be seen that the invention is there illustrated as a rotary punching apparatus indicated generally as (10). A web workpiece W is illustrated in phantom. The web moves continuously in the direction of the arrow A from an upstream location to a downstream location. Such a web may be a length of sheet metal strip, which will typically be unrolled from a coil, supported by means (not shown) located upstream which are well known in the art. The strip will be made into any desired shape usually by roll forming dies again well known in the art. In this particular case, the roll forming dies are located downstream of the apparatus (10), but this is not a prerequisite of the invention. The apparatus (10) could easily be engineered to be located downstream of the roller dies, in the case of many sheet products, if that was desired.

The web may be, at the location of the apparatus (10), a continuous strip which will eventually be cut into appropriate lengths somewhere down stream by suitable cut off die means.

In a preferred case, however, the cut off die means is located closely adjacent (upstream or downstream) to the rotary piercing apparatus (10) (the cut off die means being not shown) so that the web may be cut to appropriate lengths where it is still flat, either just before or just after the piercing of the openings in the manner described below.

In this case, where the web is cut while it is still flat, the individual web lengths will be formed in the roller dies (not shown) into the appropriate shapes, in this particular embodiment. Clearly in other embodiments there may be no roller dies at all. This may well be the case where, for example, the end product is the cut out portions from the web or where indeed the end product of the web is itself flat.

The invention is illustrated in conjunction with the punching of shorter openings (12) and longer or elongate openings (14). The long and short openings are located in pairs, in the case of the particular product illustrated. In this case the product shown, purely for the purposes of explanation, will eventually make a sheet metal dry wall stud . Such studs are known per se, Fig 2 is a typical illustration. They are usually of rectangular C-shaped channel in cross section, usually having edge flanges turned over along the two sides of the edges of the stud. In accordance with industry practice the studs are required to have short openings (12) and long openings (14) spaced apart along the longitudinal axis of the studs, as

generally illustrated in Fig 3 and 4. These openings permit services such as plumbing and electrical services to passed along within the wall, as is well known in the industry.

The short openings (12), usually circular openings, are punched with single punch dies. The long or elongate openings (14) have significant length along the longitudinal axis of the web. It is these openings which cause the problems described above and the invention is particularly directed to the high speed rotary punching of such openings having significant length. Advantageously, the invention also punches both the short openings and the elongate openings having significant length, in sequence on the same rotary apparatus, in the manner to be described below.

However, in some cases it might conceivably occur that it was desirable to punch the short openings at a separate pair of rolls, by more conventional apparatus.

It will of course be appreciated that the formation of the longitudinal bends to form a C-shaped channel (Fig. 4), will usually take place down stream from the rotary apparatus (10) in roll forming apparatus R in the illustrated example as described above. The formation of such longitudinal rectangular C-shaped bends will be carried out using conventional roll forming dies such as are well known in the art and require no description or illustration.

It will also be appreciated that while the invention is illustrated as being used in this particular case in the process of making dry wall studs, the invention is of much wider application. The invention may be used in any situation where openings are required to be pierced through a moving web at precisely spaced longitudinal intervals. Alternatively, the invention may be employed where it is desired to stamp out portions of work pieces of a particular shape from a moving web. In this case, the stamped or pierced portions from the end product.

The web material may typically be sheet metal but in other cases may be a variety of other materials which may require to be punched pierced or stamped out in this way, at high speed and with great precision from a moving web.

Referring once again to Fig 1, the apparatus (10) will be seen to comprise a base (20) which may be part of a continuous production line, but is merely illustrated here separately for the sake of explanation. Mounted on the base (20) is a machine body (22). The body (22) is an integral solid block of metal, in this embodiment.

Body (22) defines a lower mounting plate (24), a generally upright side portion (26), a lower cantilever transverse support (28) and an upper cantilever transverse support (30).

Between the supports (28) and (30), a generally elongated space (32) is defined. The web W extends into the space (32), so that the web can move continuously between the lower and upper supports (28) and (30), in a manner described below.

As mentioned, all of plate (24), side portion (26), lower support (28) and upper support (30) are made of a solid integral block of metal in this embodiment.

Within suitable bores (34) and (36) in lower and upper supports (28) and (30), there are mounted lower and upper roller drive shafts (38) and (40). The roller drive shafts (38) and (40) run in suitable inner bearings (not shown) outer bearings (not shown) mounted in the free ends of lower and upper supports.

The two shafts (38) and (40) extend out through the side body (26), and are connected for co-rotation in opposite directions by means of lower and upper gears (50) and (52) meshing together.

A drive train comprising a motor (54) and a clutch or brake mechanism (56) are connected in this case to the upper shaft (40). The motor or brake mechanism are illustrated merely as blocks, since they are generally well know in the art and require no special description. Adjustable clamps (58) key gears (50) and (52) to their respective shafts (38) and (40).

On the cantilever ends of shafts (38) and (40) remote from the side body (26), the ends of the shafts extend outwardly relative the lower and upper supports (28) and (30). On the free ends of the lower and upper shafts, there are mounted lower and upper rotary die assemblies (60) and (62).

The respective lower and upper rotary die assemblies (60) and (62) are keyed to the free ends of their shafts (38) and (40) by any suitable means known in the art. Outwardly of the rotary die assemblies (60) and (62), there are provided lower and upper cam support plates (64) and (66), secured on the outer ends of lower and upper bodies (28) and (30) respectively.

Referring now to Figs. 2 and 9 to (18), it will be seen that in this illustrated embodiment, although without restriction, there are shown two sets of four punch dies on the upper rotary die assembly (62) and two sets of two die recesses on the lower rotary die assembly (60).

As will be seen from the schematic illustration of Fig. 3 and 4, in this particular embodiment, the web W is shown as being made with a shorter round opening (12) and a longer elongate opening (14) and, the elongate opening (14) being located down stream relative to the round opening (12). Thus as the web passes from left to right (Fig 1) and the round opening (12) is made first and the elongate opening (14) is made next. The order of the openings could readily be reversed. This explanation is for illustration only.

In order to punch the opening (12), which in this case is shorter than the opening (14), hole punch dies (70), are provided, spaced radially around the circumference of the upper die assembly (62). Hole punch dies (70) are slidably received in suitable generally radial bores (72) in the upper die assembly (62), and are normally urged inwardly by spring means (74)(Fig 9).

The hole punch die (70) is shown in isolation in Fig . 5. It comprises a die body (76) of generally rectangular shape, and having a cutting die boss (78), shaped to cut out an opening, in this case, a circular opening (12), from the web.

Within die body (76) there is provided a spring recess (80). At the opposite end of die body (76) there is provided a cam follower profile (82), the purpose of which will be described below.

The elongate opening (14) in the web is punched out by a leading moveable punch die (84), and a median fixed punch die (86) and a trailing moveable punch die (88). All of dies 84, 86 and 88 are mounted in the upper rotary die assembly (62).

Reference to Figs. 9 to (18) will illustrate the progression of the positions of the upper and the lower die assemblies (62) and (60), with the web moving from left to right in the illustrations, merely for the sake of example and illustration.

The leading moveable die (84) is mounted in a generally radial cavity (90) within the upper rotary die assembly (62), and is moveable outwardly and is normally biassed inwardly by suitable die spring means (not shown). Such die springs are in general terms well known in the art, although their use in this particular application and in a rotary die assembly is believed to be unique.

The cavity (90) is not truly radial. The axis of the cavity is offset relative to a true radius of the upper die assembly (62), by an angle in the region of 5 degrees so as to provide a more rapid and complete punching action, in a manner to be described below.

The median die (86) is a fixed die body mounted in the upper rotary die assembly (62), adjacent to the leading moveable die (84).

The trailing moveable die (88) is moveably mounted in a generally radial cavity within the upper die assembly (62) and is moveable outwardly therefrom and is normally urged inwardly by suitable die spring means (not shown) such as are well known in the art.

The upper die assembly (62) itself will be seen to define an interior circular or cylindrical recess (92), and the upper die assembly (62) will be seen to define two semi-segmental die portions (62a) and (62b) having a generally annular periphery.

Lower die assembly (60) will be seen to comprise a similar shape namely defining an interior circular or cylindrical recess (94), and the exterior shape being defined by two semi-segmental die portions (60a) and (60b) each having a generally annular periphery.

The leading, median and trailing dies (84, 86 and 88) together co-operate to punch the elongate opening (14) illustrated generally in web (W) Fig. 3. Opening (14) defines a generally linear leading edge (14a), side edges (14b), and a generally triangular trailing edge (14c). The function of the leading die (84) is to punch the leading linear edge (14a) and commence punching of the two linear side edges (14b).

The function of the median die (86) is to continue punching the two linear side edges (14b).

The function of the trailing die (88) is to punch the two generally triangular edges (14c) of the trailing portion of the elongate opening (14).

The combination of the leading and trailing dies (84) and (88) which are moveable, to provide a punching or piercing action, together with the intermediate leading die(86) is such as to punch the elongate opening, for example, in the shape illustrated at Fig. 3, with repeatability and great precision. The precise shape of the elongate opening will, of course, be defined by the profiles of the dies themselves, and may be widely varied depending upon the shape of the opening to be punched out, or alternatively the shape of the portion of the web which is desired to separate from the web itself.

Co-operating with the dies (70), and (84, 86 and 88) there are provided in the lower die assembly (60) a first complementary die recess (100) and second complementary die recess (102). The first die recess (100) has a shape and

arcuate extent corresponding to the hole punch die (70). Recess (102) has an extent equal to dies (84, 86 and 88). Within each recess (100) and (102) there are provided knock-out plates (104) and (106) slidably retained by, for example, pins (108) and (110). The inward surface of the knock-out plates (104) and (106) define cam profiles (112).

The leading dies (84) are formed in a generally similar fashion to the hole punch die (70) and are shown in isolation in Fig. 6 and 8 respectively.

For the sake of simplicity the same reference numbers are used, as in Fig. 5.

Thus the leading dies (84) will be seen to comprise a die body (76a), a die boss (78a), a spring recess (80a).

The trailing dies (88) are formed in a generally similar fashion to the hole punch die (70) and are shown in isolation in Fig. 6 and 8 respectively.

For the sake of simplicity the same reference numbers are used, as in Fig. 5.

Thus the trailing dies(88) will be seen to comprise a die body (76b), a die boss (78b), a spring recess (80b).

The leading and trailing dies (84) and (88) define on their inward ends cam profiles (120) and (121).

The median dies (86) are shown in more detail in isolation in Fig. 7.

They will be seen to comprise a plurality, in this case three, die bodies (114), each of which defines a central through bore (116) by means of which they may be mounted in position.

The bodies (114) define die cutting surfaces (122), and (123). The surfaces (122) are set at a shallow obtuse angle to the surfaces (123), so as to provide a progressive blanking action, in a manner to be described below.

The median dies (86) between dies (84) and (88) is fixed and does not therefore have a cam profile.

Located within cylindrical recess (94) of lower die assembly (60) there is provided a cam means which in this case comprises a roller (124). Roller (124) is rotatably supported on lower cam support plate (64).

Within recess (92) of upper die assembly (62) there is provided a cam means in the form of roller (130) rotatably mounted on upper cam support plate (66) and supported by means of support rolls (134) and (136).

As the lower and upper die assemblies (60) and (62) are rotated by their associated shafts, the lower die assembly (60) will rotate in a clockwise direction

(Fig. 2) and the upper die assembly (62) will rotate in a counter clockwise direction (Fig. 2).

It will be appreciated that the reference to clockwise and counter clockwise is without limitation and is merely by way of explanation of what is shown in the drawings. That the two rolls simply co-rotate in opposite directions, and it is believed that it is self evident from the drawings. They could be designed to co-rotate in the other direction.

As the two die assemblies rotate one half of a complete revolution, they will progressively move through the die positions illustrated in Figs. 9 to 18.

In Figures 9 to 12 the hole punch die (70) is punching the web (W). The inboard cam profile(82) of the die (70) is engaging the roll, so as to force the die (70) downwardly through web W. In this position, the die recess (100) (in lower assembly (62) is registering with die (70) and will receive the struck out portion from the opening (12) in the web.

Figures 9, 10, 11 and 12 show the progressive positions of the hole punch (70), and its respective die recess (10)0.

Once the hole punch (70) is withdrawn from the opening it has punched in the web, the lower and upper die assemblies (60) and (62) will continue to rotate to the positions shown progressively in Figures 13 to 18.

In Fig. 13 the leading die (84) is engaging the web (W) and its cam profile (120) is engaging the cam roller (130). The lower die assembly (60) is located with its recess (102) registering with the die (84).

In the Fig. 15 position the median die (86) is engaging the web (W) at the trailing portion from the leading edge opening(14a) and the lower die assembly (60) has rotated so that the central portion of the recess (102) is registering with the die (86) and punching side edge portion (14b).

In the Fig. 16 position, the trailing die (88) is engaging the web. The die cam profile (121) is engaging the roller (130) and the die is thus punching the web(W) to punch the remainder of the side edges(14b) and trailing edge(14c) of the opening (14).

The lower assembly (60) has also rotated an arcuate distance corresponding to the upper assembly and, in this case, the trailing end of the recess (102) is registering with the trailing die (88).

Once the four dies have performed their operations on the web, the assemblies (60) and (62) will then rotate until the arcuate surfaces (60b), (62b) are on opposite sides of the web. In this position the dies will be inactive. The two knock-out plates (104) and (106) will also have engaged in succession the roller (124) thereby ejecting the portions of the web which have been removed by the dies.

The clutch or brake (56) is then operated to halt further rotation so as to permit the web to continue to pass between the assemblies so as to leave a portion of the web free of openings.

When it is again desired to punch openings in the web the clutch or brake (56) is then operated so as to once again engage motor (54) and drive the shafts and thereby the lower and upper die assemblies so as to perform the functions described above.

It will be appreciated that in the embodiment as illustrated, there are two sets of dies, on opposite sides of the upper die assembly (62) and two sets of openings on opposite sides of the lower die assembly (60). Thus, the arcuate extent of the actual operation of each of the die assemblies, required to punch out the short openings and the elongated openings, is only about 90 degrees more or less, and the upper and lower assemblies will be at rest for an arcuate extent of approximately 90 degrees, until they are again reactivated.

Thus the entire apparatus can be started and stopped with great rapidity, so that short and long holes can be punched in the web even when the web is moving at great speed, and the spacing between the sets of short and long openings can be varied from one production run to the next, so as to suit the customers requirements.

It will, of course, be appreciated that the timing of the operation of the rolls will vary depending upon such factors as, for example, the speed at which the web is moving, the diameter of the lower and upper die assemblies, and the spacing required between the openings.

It will also be appreciated that in some cases only one such opening will be required, in which case one or some of the dies can simply be removed from the rolls.

Changes in the profile of the openings can easily be effected by simply removing the die assemblies and replacing them with other die assemblies.

The entire operation of the apparatus can be controlled, for example, by means of any suitable web sensing mechanism such as a measuring device typically

being incorporated in the apparatus (10). The sensing apparatus not shown may be connected to a suitable computer console (140) which is in turn connected to operate the motor (54) or the clutch/brake (56), depending upon the way in which the apparatus is being operated.

By the use of the invention, it is found possible to punch holes in a web moving at high speed, in metal gauges of widely varying thickness, going from the thinnest gauge practical, up to at least (12) gauge, without unduly stressing the apparatus.

While in this embodiment of the invention, the mounting in arrangement of the lower and upper die assemblies, is shown to be in a generally cantilever fashion, it will be appreciated that without departing from the scope of the invention, such lower and upper die assemblies could be rotatably mounted between die stands on opposite sides of the web, if that arrangement was found to be desirable.

The mounting and arrangement of such die assemblies in stands on opposite sides of a web is not believed to require any special description.

The foregoing is a description of a preferred embodiment of the invention which is given here by way of example only. The invention is not to be taken as limited to any of the specific features as described, but comprehends all such variations thereof as come within the scope of the appended claims.

Claims

1. A rotary punching apparatus(10) for punching elongate openings(14) in a moving web work piece(W) the elongate openings(14) having a predetermined length along the longitudinal axis of said web work piece(W)and being characterized by;

two die assemblies(60,62) located on opposite sides of the path of said web work piece(W), and power means(54) for rotating said assemblies(60,62);

a leading die(84) mounted on one said assembly(62) of said assemblies(60,62), and movement means for moving said leading die(84) generally outwardly relative to said one assembly(62) so as to punch a first die partial opening through said web work piece(W), said leading die(84) defining a leading edge opening(14a) of a said elongate opening(14);

a trailing die(88) on said one assembly(62) adjacent to said leading die(84), said trailing die(88) being located to engage and punch said web work piece(W) whereby to punch a continuation of said elongate opening(14) in said web work piece(W), thereby defining a continuous said opening(14) which is elongated along the axis of said web workpiece(W), having a predetermined length along said longitudinal axis of said web work piece(W), said trailing die(88) defining a trailing edge(14c) remote from said leading edge(14a) of said leading die(84), and;

a die recess(102) in the other(60) of said assemblies(60,62) registering with said leading(84) and trailing dies(88).

2. A rotary punching apparatus(10) as claimed in claim 1 in which said trailing die(88) operates to continue and to extend the elongate die opening(14).

3. A rotary punching apparatus(10) as claimed in claim 1 including a median die(86) between said leading(84) and trailing die(88), whereby to pierce said web work piece(W)and further define said elongate opening(14).

4. A rotary punching apparatus(10) as claimed in claim 1 including a hole punch die(70) moveable radially relative to said one assembly(62) operable to punch a further opening(12) in said web work piece(W) spaced axially along the longitudinal axis of said web work piece(W) from said elongate opening(14) punched by the leading(84) and trailing die(88), and a hole punch die recess(100) in said other assembly(60).

5. A rotary punching apparatus(10) as claimed in claim 1 and including power operated means(54) for rotating said die assemblies(60,62), the power operated means(54) being operable intermittently so as to punch the openings at desired longitudinal spacings along the axis of said web workpiece(W), and whereby the assemblies(60,62) are held stationary where openings are not required so as to permit said web work piece(W) to pass between the assemblies(60,62) without openings being punched.

6. A rotary punching apparatus(10) as claimed in claim 5 wherein the power operated means(54) comprises an intermittently operable motor(54).

7. A rotary punching apparatus(10) as claimed in claim 6, and further including intermittently operable clutch means(56), whereby to disconnect said power operated means(54) from said die assemblies(60,62).

8. A rotary punching apparatus(10) as claimed in claim 1 wherein the assemblies(60,62) are mounted in a cantilever fashion in a stand located along one side edge only, of the web path, said assemblies(60,62) being long enough to extend partly across said web work piece(W)to locate said dies(70,84,86,88) along the desired piercing axis of said web work piece(W).

9. A rotary punching apparatus(10) as claimed in claim 1 including leading die operating cam means(130,134,136), in said one assembly(62) the leading die(84) extending into said one assembly(62) and terminating in cam follower means(120) located to be engaged by said cam means(130,134,136).

10. A rotary punching apparatus(10) as claimed in claim 1 including trailing die operating cam means (130,134,136) in said one assembly(62), said trailing die(88) extending into said one assembly(62) and terminating in cam follower means(121) located to be engaged by said cam means(130,134,136).

11. A rotary punching apparatus(10) as claimed in claim 4, including hole punch die operating cam means(130,134,136) in said one assembly(62), said hole punch die(70) extending into said one assembly(62) and terminating in cam follower means(82) located to be engaged by said cam means(130,134,136).

12. A rotary punching apparatus(10) as claimed in claim 4 and including knock out means(104,106) to eject the struck out web portions from said recesses(100,102) in said other(60) of said assemblies(60,62).

13. A rotary punching apparatus(10) as claimed in claim 1, and wherein there are two sets of said leading(84) and said trailing dies(88), mounted at spaced locations around said one die assembly(62), and wherein there are at least two sets of said die recesses(102,102), registering with respective said sets of said leading(84) and trailing dies(88).

14. A rotary punching apparatus(10) as claimed in claim 1, and including a second hole punch die(70), and a second hole punch recess(100), registering therewith.

15. A rotary punching apparatus(10) as claimed in claim 12, wherein said knock out means(104,106) are movable in a generally radial fashion relative to said other(60) of said die assemblies(60,62), and including movement means(124) for said knock out means(104,106).

16. A rotary punching apparatus(10) as claimed in claim 1, and including a cavity(90) in said one assemblies(62), for slidably receiving said leading die(84), said cavity(90) being located along an axis which is off set relative to a radius of said one said assembly(62).

17. A rotary punching apparatus(10) as claimed in claim 3, and wherein said median die(86) is fixed to said one(62) of said assemblies(60,62), and wherein said median die(86) defines two punching surfaces(122,123), said punching surfaces(122,123) being located at an obtuse angle to one another.

18. The method of punching an elongate opening in a continuously moving web work piece(W) and comprising the steps of passing said web work piece(W) between a pair of rotary die assemblies(60,62), one(62) of said die assemblies(60,62) carrying a leading movable die(84), and a trailing movable die(88) adjacent to one another, said leading(84) and trailing(88) movable dies being movable upon rotation of said one of said assembly(62), whereby to move sequentially outwardly from said assembly(62), and punch said web work piece(W), said leading die(84) punching a leading edge(14a) of said elongate opening(14), and said trailing die(88) punching a trailing edge(14c) of said elongate opening(14), and said leading(84) and trailing(88) dies punching side edges(14b) of said elongate opening(14) between said leading and trailing edges(14a,14c).

19. The method as claimed in claim 18, including the step of punching said web work piece(W) by means of median die means(86) located between said leading(84) and trailing dies(88), said median die(86) punching side edges(14b) of said elongate opening(14) between said leading die(84) and said trailing die(88).

20. The method as claimed in claim 19, including a step of further punching a further opening in said web work piece(W), by means of a hole punch die(70) spaced from said leading(84) and trailing die(88), whereby to punch said web work piece(W) with two spaced apart openings(12,14).

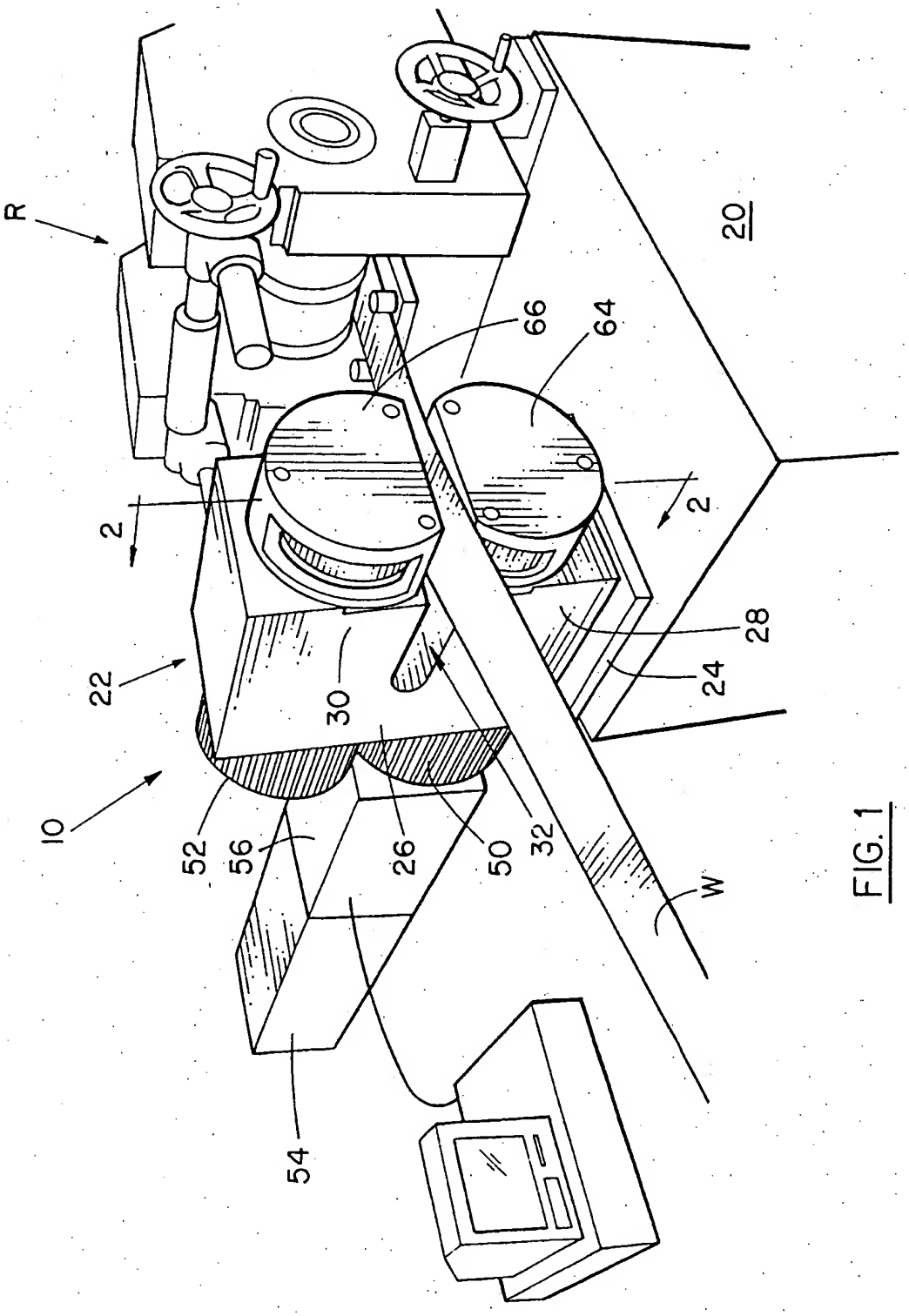
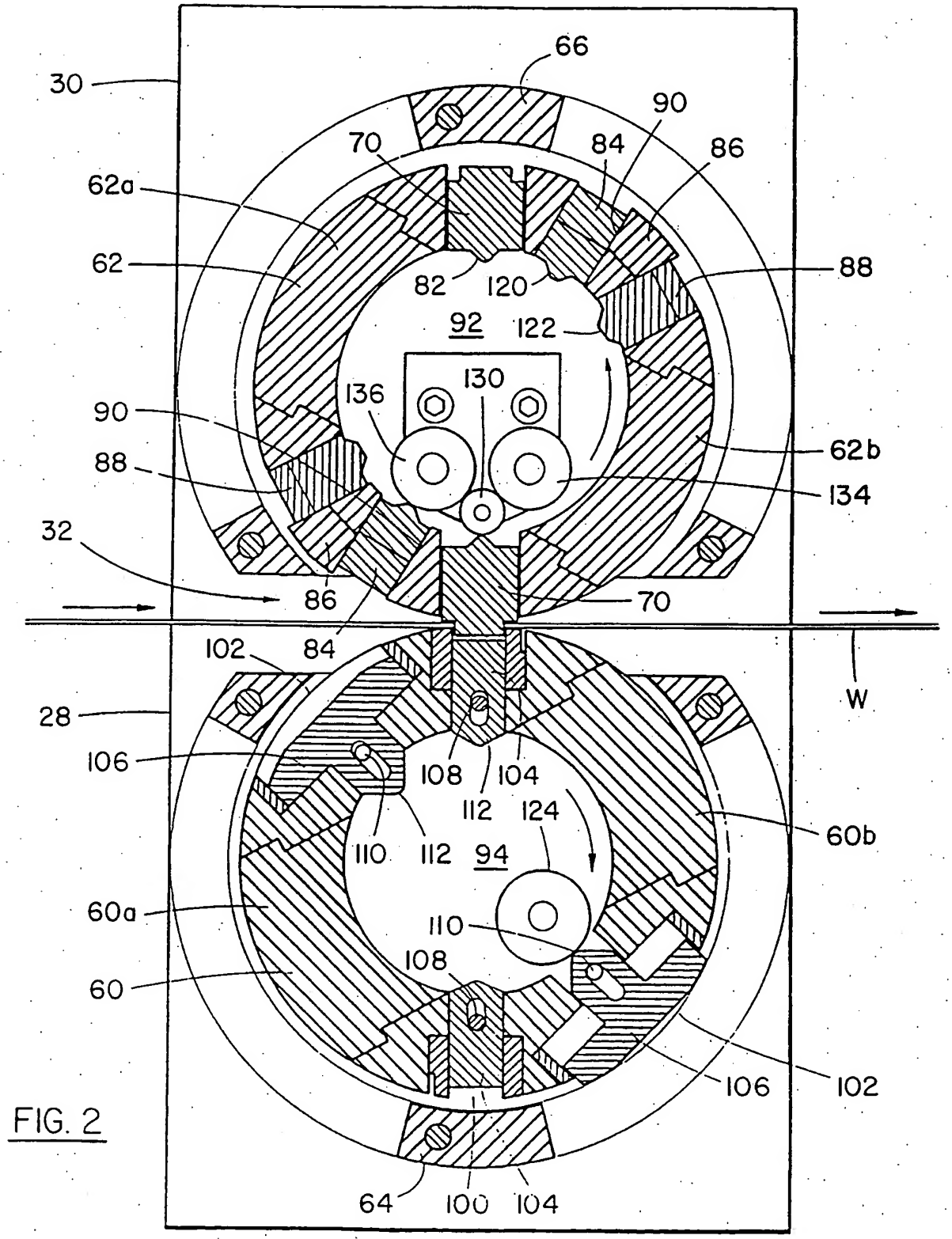


FIG. 1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62a
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92
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136
90
62b
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102
84
W
28
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64
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104

FIG. 2

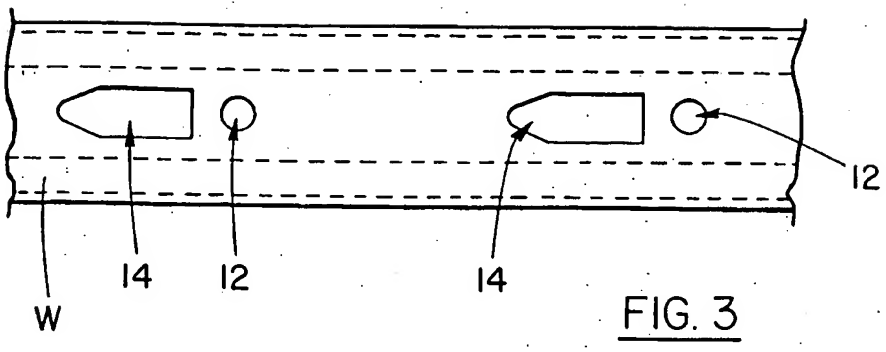

FIG. 3

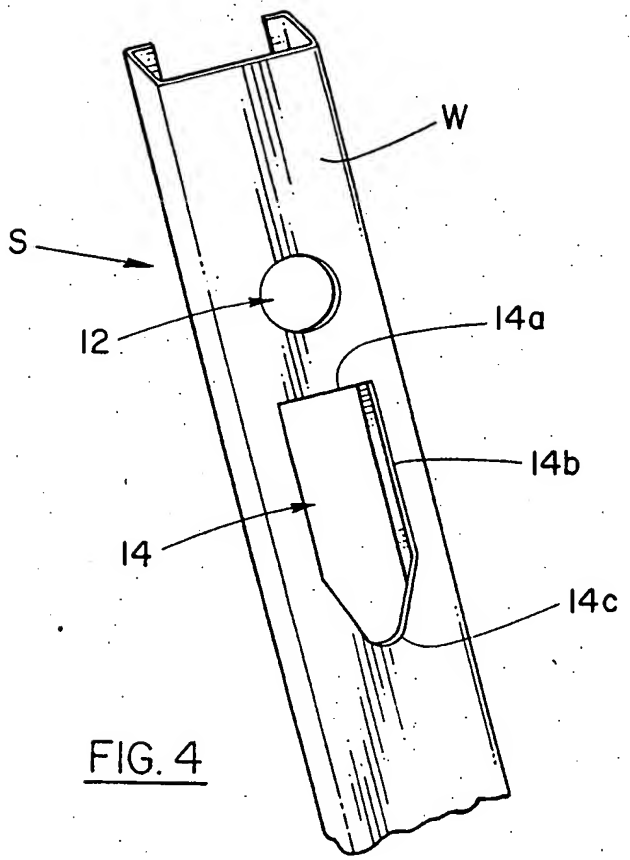

FIG. 4

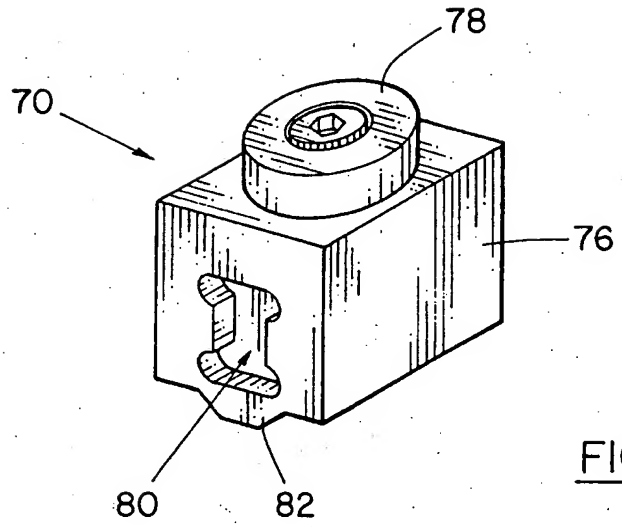

FIG. 5

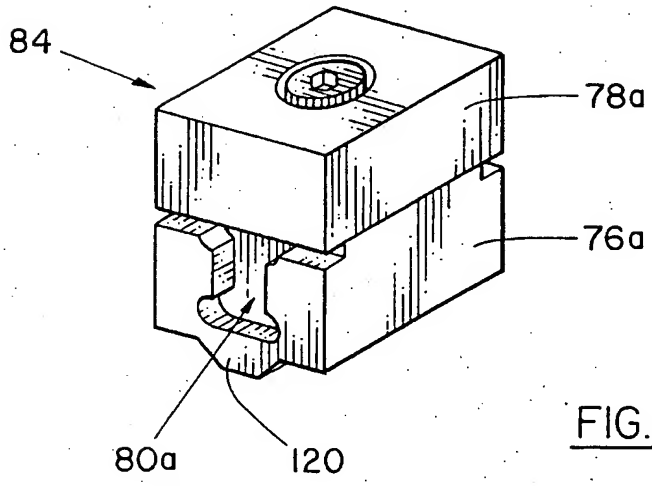

FIG. 6

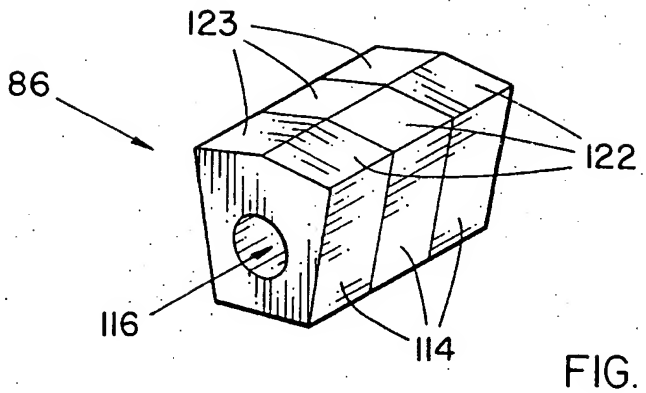

FIG. 7

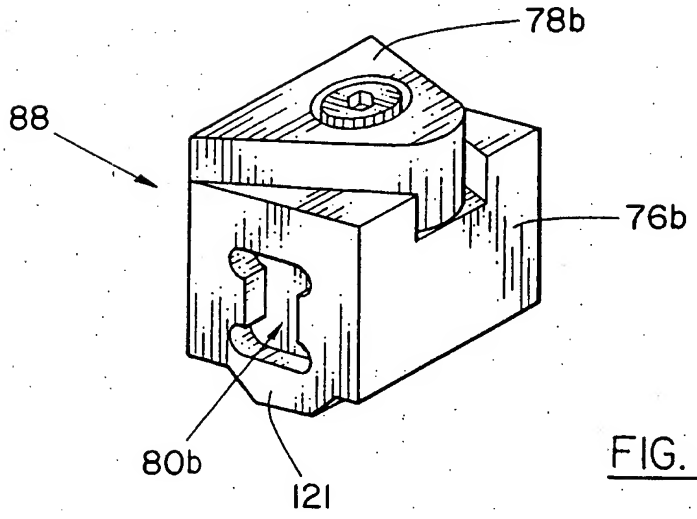

FIG. 8

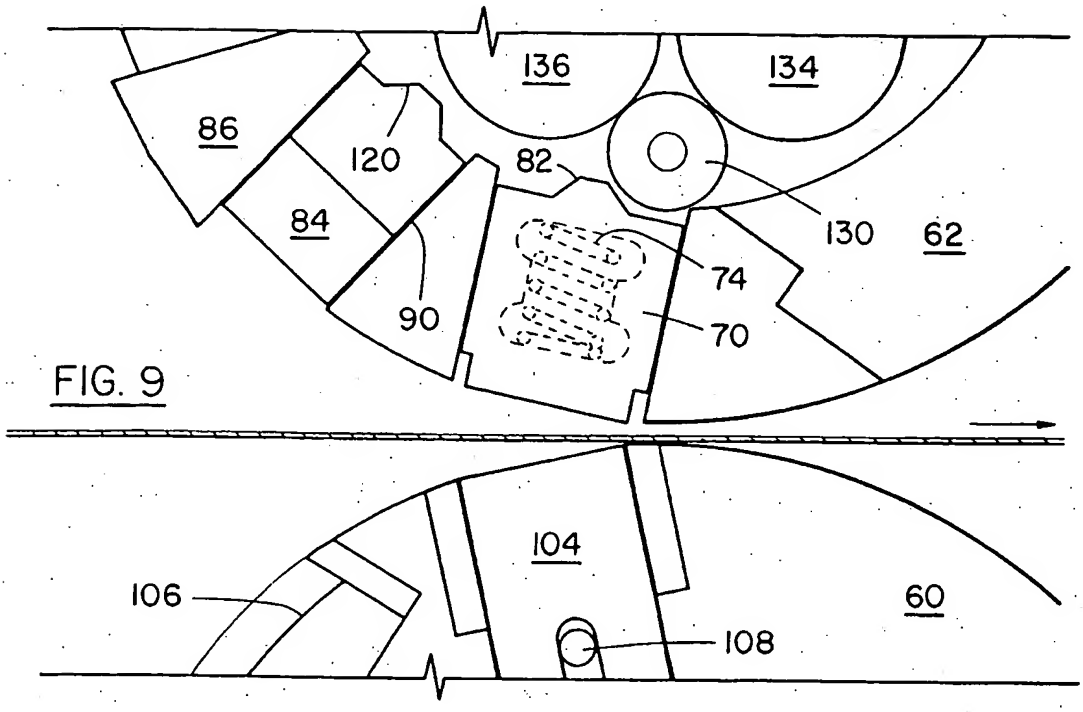
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FIG. 9

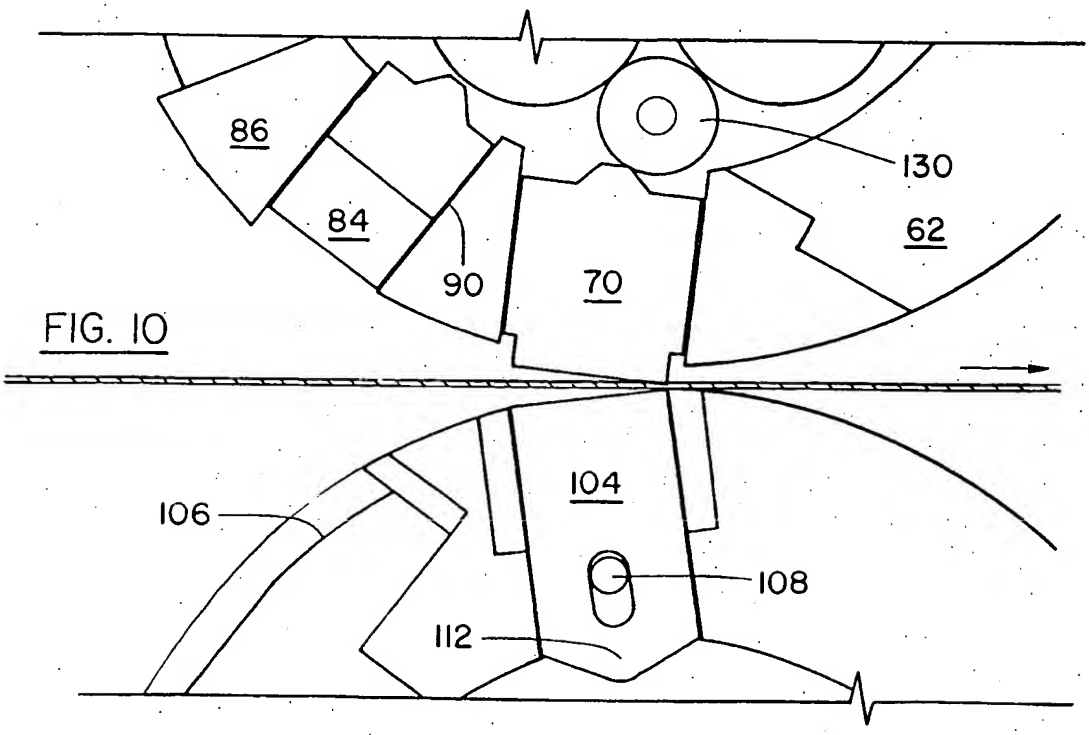
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FIG. 10

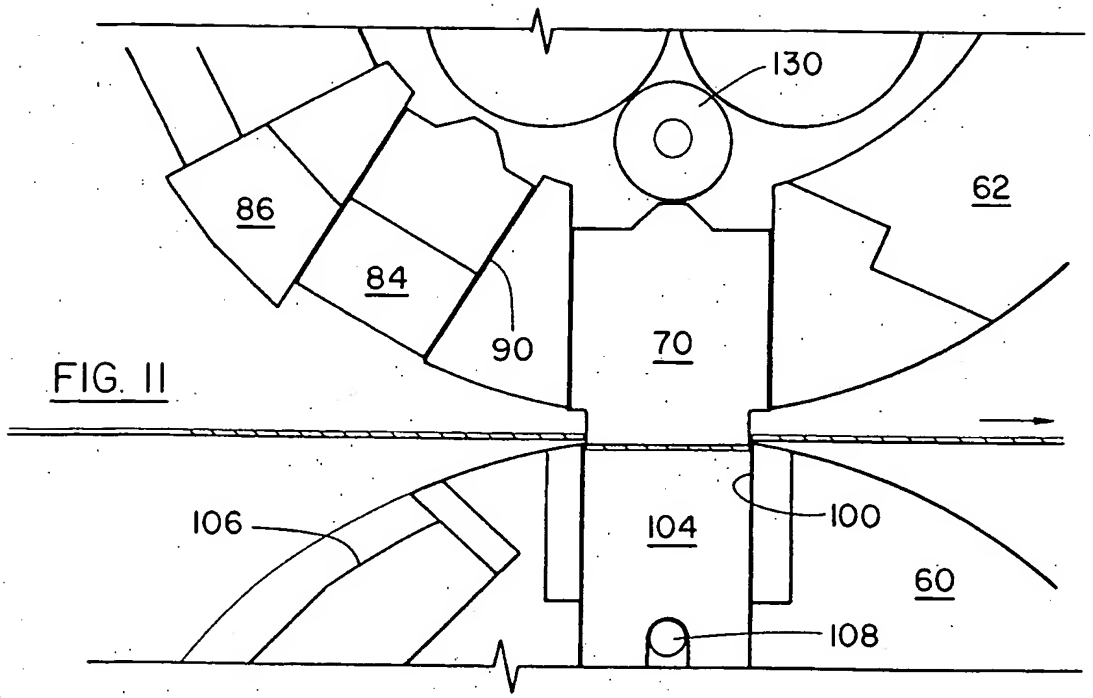
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FIG. 11

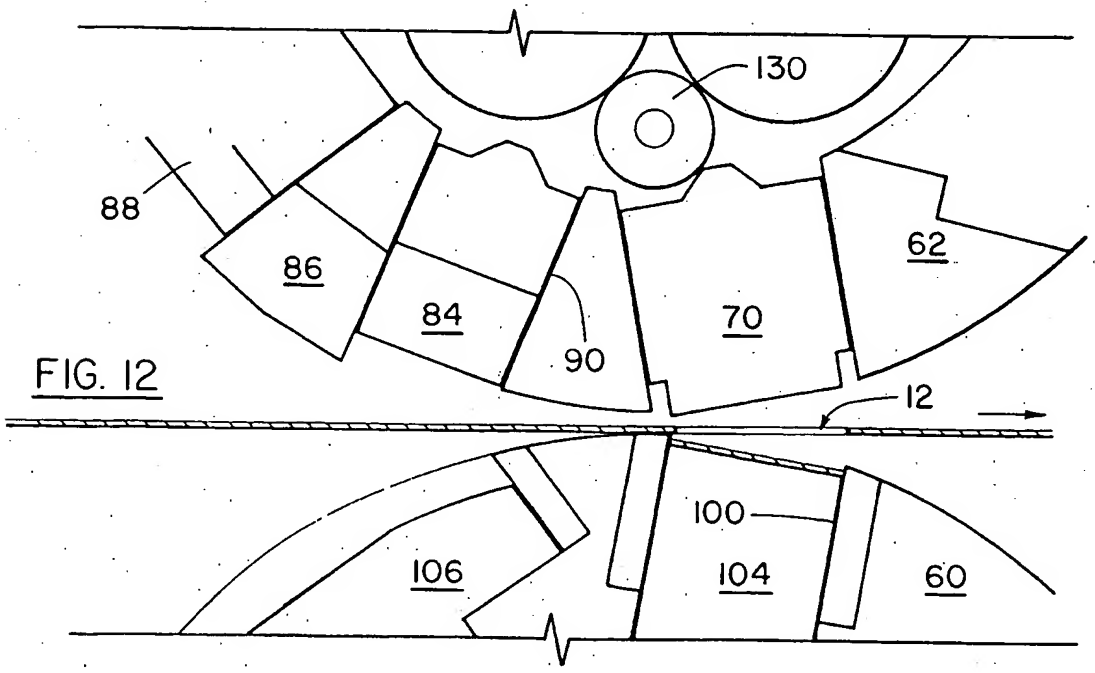
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FIG. 12

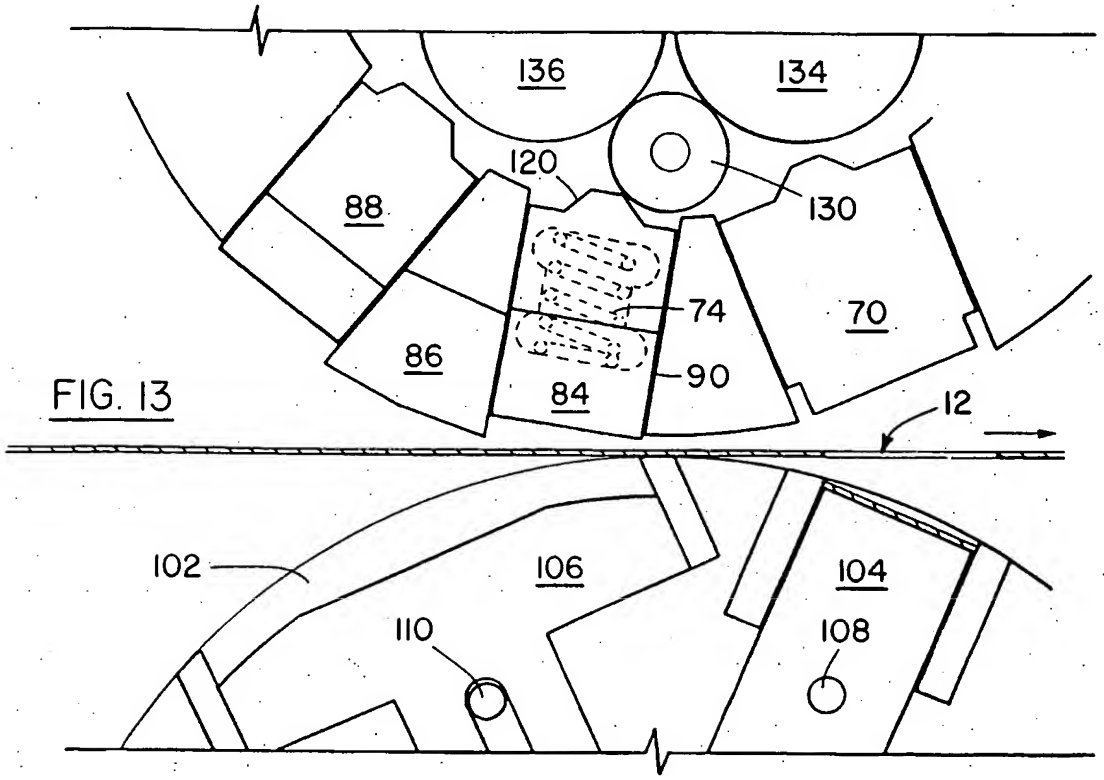
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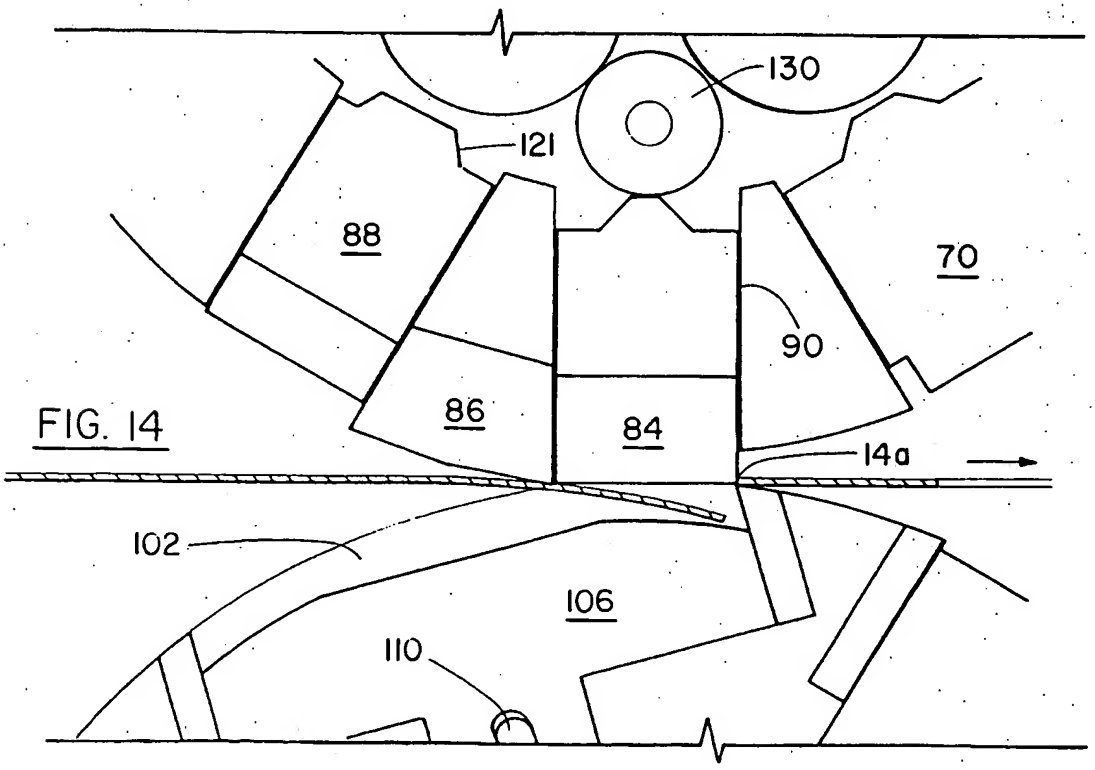
FIG. 13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14a
102
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110

FIG. 14

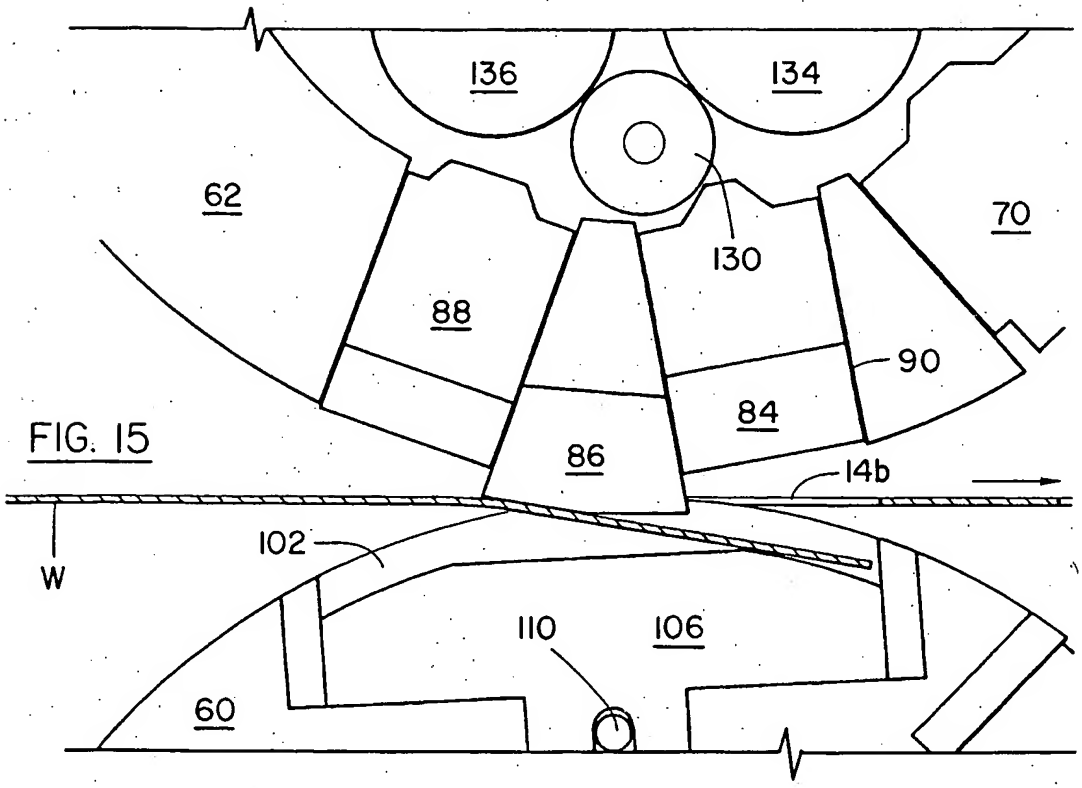
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FIG. 15

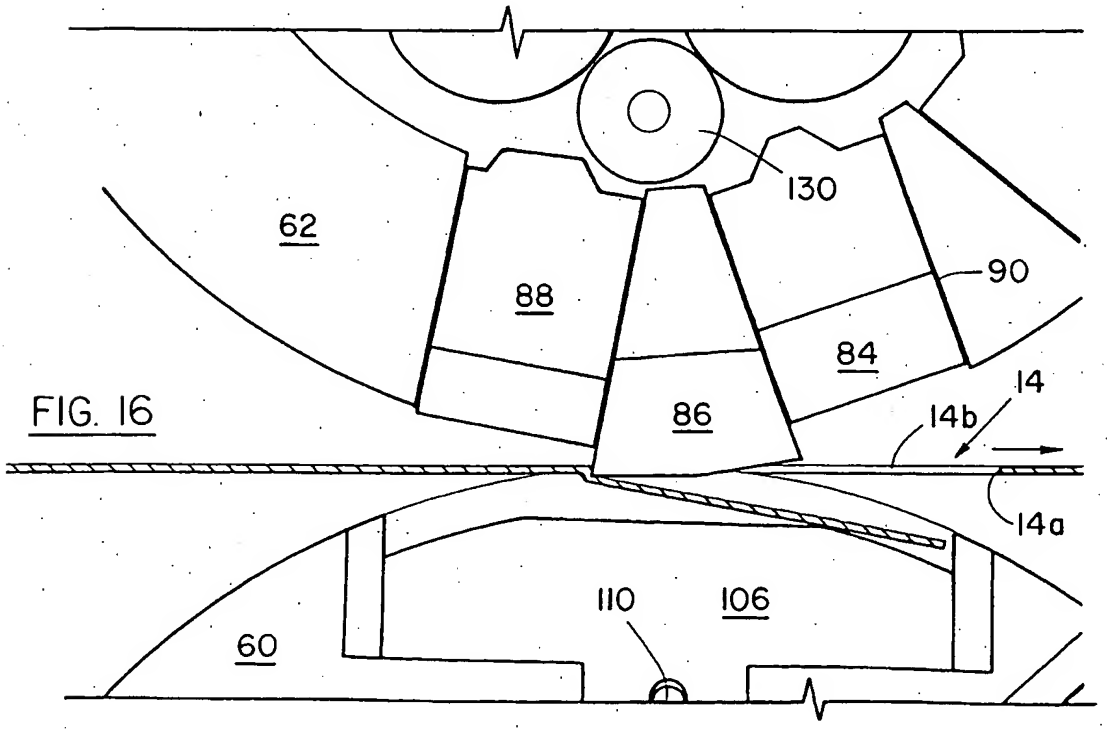
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FIG. 16

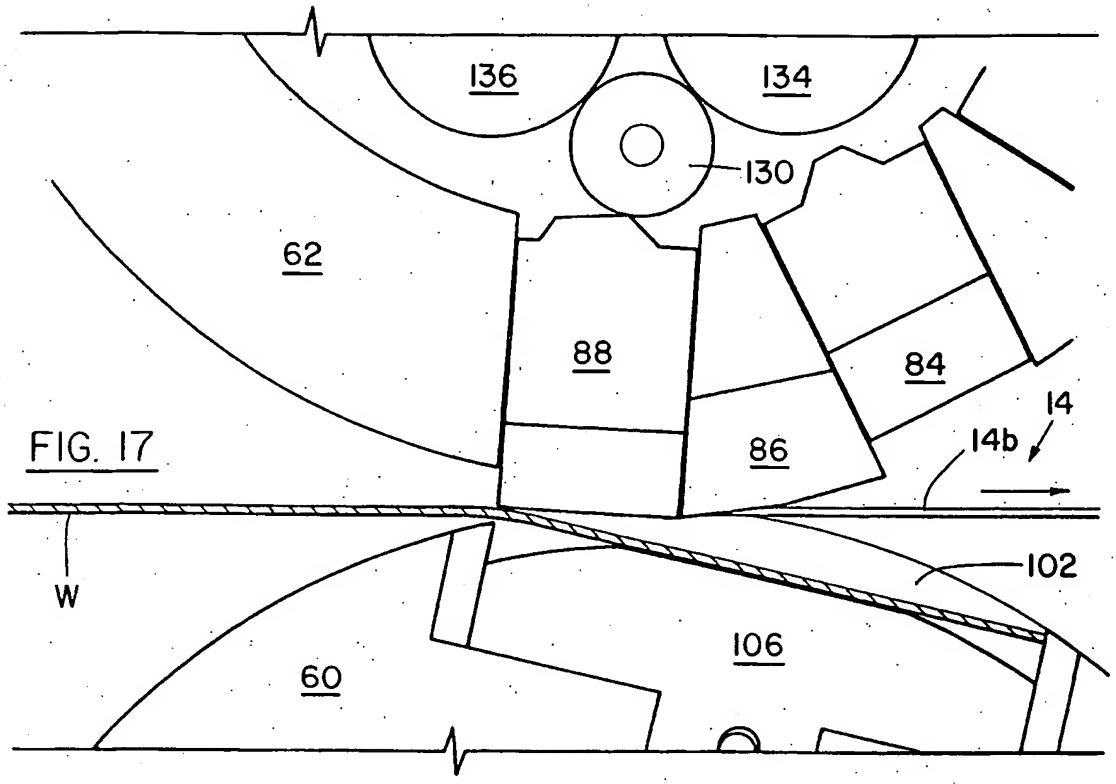
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FIG. 17

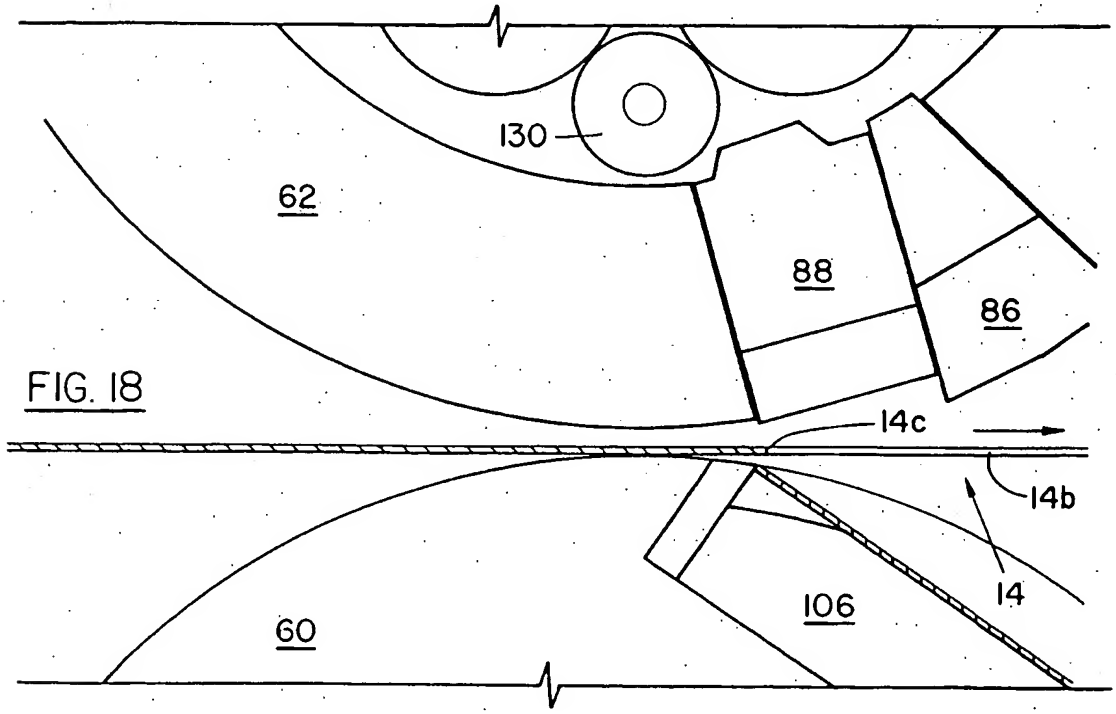
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FIG. 18

INTERNATIONAL SEARCH REPORT

Intern. ial Application No
PCT/CA 00/01288

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B21D28/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B21D B26F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 949 020 A (DENSO CORP) 13 October 1999 (1999-10-13) paragraph '0022! - paragraph '0031!	1,18
A	DE 43 19 300 A (BAUST WERKZEUGTECHNIK GMBH) 22 December 1994 (1994-12-22) column 3 -column 4	1,18
A	US 2 083 370 A (GREULICH) 8 June 1937 (1937-06-08) the whole document	1,18

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 March 2001	05/04/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Gerard, O

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat. ial Application No
PCT/CA 00/01288

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0949020 A	13-10-1999	JP 11347649 A US 6119568 A	21-12-1999 19-09-2000
DE 4319300 A	22-12-1994	NONE	
US 2083370 A	08-06-1937	NONE	